

*REMARKS/ARGUMENTS**The Pending Claims*

The pending claims are directed to chemical-mechanical polishing compositions, as well as methods of polishing a substrate using the same. Claims 1-10, 14-31, and 35-42 currently are pending. Reconsideration of the claims is respectfully requested in view of the remarks herein.

Discussion of the Claim Amendments

Claim 1 has been amended to recite that the chemical-mechanical polishing composition comprises about 2.5×10^{-2} to about 2.5 mmol/kg of calcium, about 1×10^{-2} to about 1.5 mmol/kg of strontium, or about 7×10^{-3} to about 0.75 mmol/kg of barium, based on the total weight of the polishing composition. Claim 21 has been amended to recite that the chemical-mechanical polishing composition comprises about 2.5×10^{-2} to about 2.5 mmol/kg of calcium or about 1×10^{-2} to about 1.5 mmol/kg of strontium, based on the total weight of the polishing composition. Support for these amendments can be found in the present specification at paragraph [0018]. Claims 11-13 and 32-34 have been canceled. No new matter has been added by way of these amendments.

Summary of the Office Action

Claims 1-42 stand rejected under 35 U.S.C. § 103(A) as allegedly unpatentable over U.S. Patent Application Publication 2001/0006224 A1 (Tsuchiya et al.) (hereinafter "the Tsuchiya '224 publication").

Discussion of the Obviousness Rejection

The pending claims require, among other things, the use of about 2.5×10^{-2} to about 2.5 mmol/kg of calcium, about 1×10^{-2} to about 1.5 mmol/kg of strontium, or about 7×10^{-3} to about 0.75 mmol/kg of barium. These ranges are equivalent to about 0.0001 to about 0.01 wt.% of calcium, 0.000088 to about 0.0088 wt.% of strontium, and about 0.000069 to about 0.01 wt.% of barium.

The Tsuchiya '224 publication discloses a polishing composition comprising silica and 0.01-10 wt.% of an inorganic salt. The inorganic salt can contain ammonium ions, alkali metal ions, alkaline earth metal ions, group IIIB metal ions, group IVB metal ions, group VB metal ions, and transition metal ions (Tsuchiya publication at paragraph [0029]). The Tsuchiya '224 publication lists as specific examples 48 different metal ions. The Tsuchiya '224 publication further teaches that the polishing composition can comprise an oxidizing agent, and that the polishing composition can have a pH of about 3 to about 9. The Office Action acknowledges that the Tsuchiya '224 publication does not disclose the specific polishing process parameters recited in the pending claims, but asserts that it would have been obvious to employ any of a variety of different polishing process parameters, including the parameters recited in the pending claims.

In view of the disclosure of the Tsuchiya '224 publication, one of ordinary skill in the art, in order to arrive at the claimed invention, would have to select calcium, strontium, and barium as cations from the list of 48 metal cations and ammonium cation disclosed therein, and would have to select an appropriate amount of a salt providing calcium ion, strontium ion, or barium ion to provide about 2.5×10^{-2} to about 2.5 mmoles/kg of calcium, about 1×10^{-2} to about 1.5 mmoles/kg of strontium, or about 7×10^{-3} to about 0.75 mmoles/kg of barium. However, there is nothing within the broad disclosure of the Tsuchiya '224 publication that would teach or suggest to the ordinarily skilled artisan to properly make the two choices, as discussed in more detail below.

(a) Selection of the Metal Cation

Calcium, strontium, and barium represent only 3 of the 48 metal cations, plus ammonium ion, disclosed as suitable components of the inorganic salts of the Tsuchiya '224 publication. The Tsuchiya '224 publication provides no teaching or suggestion that would lead one of ordinary skill in the art to select calcium, strontium, or barium over the other available choices. Indeed, the Tsuchiya '224 publication teaches away from the choice of salts containing calcium, strontium, and barium, inasmuch as the Tsuchiya '224 publication teaches that preferable salts are ammonium and potassium salts (Tsuchiya '224 publication at paragraph [0037]).

Furthermore, Applicants have discovered unexpected results attendant the use of calcium, strontium, and barium in the polishing of substrates comprising tantalum. As demonstrated by Example 1 of the present application, a polishing composition comprising 0.50 mmoles/kg of calcium exhibited a tantalum removal rate that was at least 5.4 times greater than the tantalum removal rate observed for similar polishing compositions comprising 7.41 mmoles/kg of aluminum (5.9 times greater), 0.82 mmoles/kg of magnesium (5.4 times greater), 1.04 mmoles/kg of titanium (6.9 times greater), 0.33 mmoles/kg of zirconium (7.6 times greater), and 0.54 mmoles/kg of iron (7.4 times greater). Moreover, as demonstrated by Example 4 of the present application, polishing compositions comprising 1.0 mmoles/kg of calcium, 0.46 mmoles/kg of strontium, and 0.29 mmoles of barium exhibited tantalum removal rates that were essentially the same and were 7.1 times, 6.9 times, and 6.4 times the tantalum removal rates observed for a control polishing composition, despite different concentrations of the metals in the polishing compositions.

(b) Selection of the Metal Cation Concentration

The Tsuchiya '224 publication teaches a broad concentration range of 0.01-10 wt.% of the inorganic salt in the disclosed polishing composition. However, the Tsuchiya '224 publication provides no teaching or suggestion that would lead one of ordinary skill in the art, at the time of invention, to use an amount of a source of calcium, strontium, or barium to provide about 2.5×10^{-2} to about 2.5 mmoles/kg of calcium, about 1×10^{-2} to about 1.5 mmoles/kg of strontium, or about 7×10^{-3} to about 0.75 mmoles/kg of barium, as required by the pending claims.

The Office Action asserts that the claimed concentration range could be arrived at by "routine experimentation." However, as discussed above in connection with the choice of the metal cation, Applicants have discovered that polishing compositions comprising calcium, but not aluminum, magnesium, titanium, zirconium, or iron, unexpectedly exhibit tantalum removal rates ranging from 5.4 times to 7.4 times greater than the tantalum removal rates for polishing compositions comprising aluminum, magnesium, titanium, zirconium, or iron, at a calcium concentration less than the concentrations of the comparative metal cations (except for zirconium). Thus, the ordinarily skilled artisan, on considering the disclosure of the Tsuchiya '224 publication, would have had, absent any guidance in the disclosure of the


Tsuchiya '224 publication, to formulate a polishing composition comprising each of the 48 metal cations, as well as ammonium ion, disclosed therein, at some concentration of the metal cations or ammonium ion, and then would have had to determine the tantalum removal rate of the 49 separate polishing compositions. Moreover, the ordinarily skilled artisan would have had to disregard the teaching of the Tsuchiya '224 publication that the polishing composition disclosed therein preferably contains at least 0.05 wt.% of the inorganic salt in order to prepare polishing compositions comprising about 2.5×10^{-2} to about 2.5 mmoles/kg of calcium, about 1×10^{-2} to about 1.5 mmoles/kg of strontium, or about 7×10^{-3} to about 0.75 mmoles/kg and barium. In addition, the ordinarily skilled artisan would have had to recognize that the tantalum removal rates exhibited by polishing compositions comprising calcium, strontium, and barium depend on the concentration of calcium, strontium, and barium, and not on the percentage by weight of the inorganic salts in the polishing compositions which provide the calcium, strontium, and barium.

In view of the foregoing, it cannot properly be asserted that the subject matter recited in the pending claims could be arrived at by "routine experimentation." Accordingly, the obviousness rejection of the pending claims is improper and should be withdrawn.

Conclusion

Applicants respectfully submit that the patent application is in condition for allowance. If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,



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